

Rapide Croche Lock and Dam  
At the 22.8 mile marker  
on the Lower Fox River  
Wrightstown  
Outagamie County  
Wisconsin

HAER No. WI-91

HAER  
WIS  
5-WR10,  
2-

## PHOTOGRAPHS

## WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD  
Rocky Mountain System Support Office  
National Park Service  
P.O. Box 25287  
Denver, Colorado 80225-0287

# HISTORIC AMERICAN ENGINEERING RECORD

## RAPIDE CROCHE LOCK AND DAM

HAER NO. WI-91

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**Location:** The Rapide Croche Lock and Dam Complex is located on the north bank of the Fox River at river mileage marker 22.8 in the SE1/4 of Section 4, T21N, R19E, Civil Town of Buchanan, Outagamie County, Wisconsin.

**UTM:**  
Southwest end of dam 16/404400/4907260;  
Northeast end of dam 16/404500/4907420;  
Center of lock 16/404600/4907450;  
USGS Quadrangle: Wrightstown, Wisconsin 7.5' series

**Date of Construction:** 1849-1975

**Engineer:** United States Army Corps of Engineers with Contractors

**Architect:** United States Army Corps of Engineers with Contractors

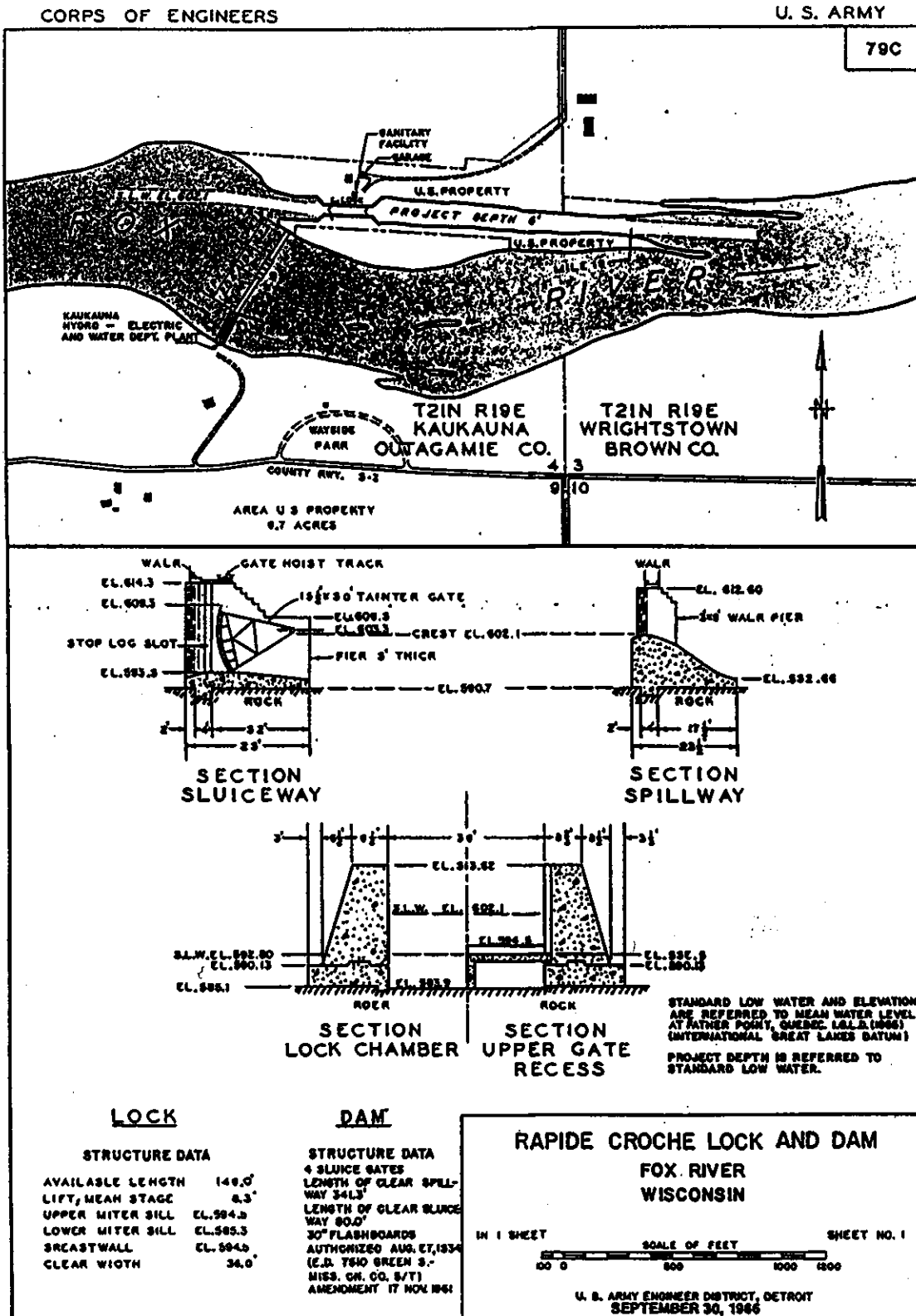
**Present Owner:** United States Army Corps of Engineers

**Present Use:** The Rapide Croche Lock is currently not in use. The dam at Rapide Croche remains operational.

**Significance:** The Rapide Croche Lock and Dam Complex allowed water navigation around rapids in the Fox River for boats traveling between Kaukauna and Green Bay. This complex served as an integral part of the Lower Fox River Waterway System.

**Project Information:** This documentation was undertaken in 1995 in accordance with requirements detailed in a June 19, 1994 letter from Gregory D. Kendrick, Chief, History Branch, NPS to Dale Monteith, Acting Chief, Planning Division, USACOE, Detroit District. The Lower Fox system remains basically operational but was placed in caretaker status by the USACOE in 1982. The USACOE plans to divest itself of the Lower Fox system as soon as is feasible; therefore, NPS requested this documentation. All documentation conforms to HAER standards.

Dr. John D. Richards, Principal Investigator; Georgia A. Lusk, Patricia B. Richards, and Robert J. Watson, Project Archivists with Great Lakes Archaeological Research Center, Inc.; Joseph Paskus, Project Photographer.



## RAPIDE CROCHE LOCK AND DAM

### General Description

The Rapide Croche Lock and Dam Complex is located on the north bank of the Lower Fox River at river mile 22.8. The complex consists of a dam, lock, canal, lockkeeper's residence, lock shelter, garage, storage building and a sanitary building. The facilities present at this complex are located in a rural setting between the cities of Kaukauna and De Pere.

### History

In 1848, The Board of Public Works of the State of Wisconsin appointed engineer Condly R. Alton to survey and assess the condition of the dams on the Fox River and suggest navigational improvements to other areas of the river.<sup>1</sup> Following the survey, Alton noted slight rapids at Rapide Croche near Wrightstown and proposed the construction of a 650 foot long, 6 foot high dam. He also felt that one lock with a 6 foot lift situated within an 800 foot canal would be adequate to allow boat travel through the rapids. In his report, Alton recommended that the lock at Rapide Croche be among the first projects undertaken to make the Fox River more easily navigable.<sup>2</sup>

In May of 1849, a contract was awarded to Joseph Maynard for the building of the lock and dam at Rapide Croche.<sup>3</sup> By the close of the 1849 construction season, a brush and stone dam (no longer extant) was completed; the associated canal and lock remained under construction.<sup>4</sup> On June 14, 1850, the first vessel passed through the De Pere lock and navigated the Fox River to Rapide Croche, which was still under construction. By August, the Indiana, a steamship from Green Bay, was making daily trips through De Pere to Rapide Croche. The Milwaukee Sentinel reported that the Rapide Croche facilities would be operational by mid-September of 1850.<sup>5</sup> Construction was complicated by a cost overrun resulting from the discovery that the floor of the lock needed to be lowered because of intermittent low water levels. In spite of this setback, the lock and canal at Rapide Croche were completed in 1850.<sup>6</sup>

From 1850-51 the brush and stone dam at Rapide Croche washed out several times because the flat rock river bed was poorly suited to support a dam that was not securely anchored. In order to remedy this problem, construction of a new spar dam, one which is bolted to the rock of the river bed was begun in 1851.<sup>7</sup>

Due to financial difficulties involving the Fox-Wisconsin project, a legislative committee was formed in April of 1853, and began an investigation into the status of the locks and dams on the Fox River.<sup>8</sup> Inspection of the facilities on the Fox-Wisconsin Waterway took place one month later in May, and a report was completed in June of the same year.<sup>9</sup> In the report, the investigators stated that although the Rapide Croche Lock and Dam were complete, the facilities were inadequate, and would require an additional \$17,000 of modifications.<sup>10</sup>

In 1856, the Aquila became the first steamer to successfully navigate the Fox-Wisconsin Waterway from the Mississippi River to Green Bay.<sup>11</sup> Although the Aquila successfully completed the journey, several locations along the route were plagued with water levels too low for steamer traffic during the late summer or at times of low water.

In 1866, a survey of the Fox-Wisconsin system was conducted in order to identify the major trouble spots along the waterway. At Rapide Croche, the surveyors found a "fine stone lock" located within an 1800 foot canal.<sup>12</sup> The Rapide Croche dam, the only stone dam on the Fox

River, was found to be 440 feet long and 6 feet high.<sup>13</sup> As a result of the 1866 survey, it was determined that the depth of the Fox-Wisconsin Waterway needed to be increased in order to allow for the passage of vessels drawing up to 4 feet.<sup>14</sup>

Following the purchase of the Fox-Wisconsin Lock and Dam System by the federal government in 1872, Major D.C. Houston was assigned responsibility for operation of the waterway. One of Houston's first actions was to initiate an additional conditions survey. Results identified the lock at Rapide Croche as "a fine piece of work, being of cut-stone masonry."<sup>15</sup> The report also stated that the dam maintained an adequate water level, but needed additional reinforcement.<sup>16</sup>

In 1903, plans were prepared for a new lockkeeper's residence at Rapide Croche, with construction taking place in 1906.<sup>17</sup> The design included the lockkeeper's residence with a fence enclosing a 150 foot square area.<sup>18</sup> A lock shelter and a single story shed were constructed around 1917.<sup>19</sup>

In 1931, the Rapide Croche dam was rebuilt of poured concrete.<sup>20</sup> At the same time that the dam was rebuilt, plans were developed to replace the Rapide Croche lock with a new reinforced concrete construction over a three year period.<sup>21</sup> The reconstruction of the lock was completed in 1934, although the old lock was not yet removed.<sup>22</sup> With the completion of the new lock and dam, the Rapide Croche Lock and Dam facility attained its present form. In subsequent years, the lockkeeper's house was moved approximately 650 ft west of its original location and a barn located at the complex was demolished. A sanitary facility was added in the 1960s, and a garage was built circa 1975.<sup>23</sup>

## **RAPIDE CROCHE DAM**

The existing dam at Rapide Croche has changed little structurally since it was rebuilt in concrete between 1930 and 1931. Oriented SE/NW, the dam is 461 feet 3 inches in length and is comprised of three sections: (1) a spill way located on the northern end of the dam; (2) a spillway located on the dam's southern end; and (3) a centrally located sluiceway.<sup>24</sup> The dam is anchored to the bedrock at the river's bottom and maintains a standard low water lower pool elevation of 594.5 feet above mean sea level.<sup>25</sup> Due to unique engineering challenges posed by the Fox River, each section of the Rapide Croche dam differs in design and construction from the other sections of the dam. Each section of the dam is described below.

### North (Left) Spillway

The north (left) spillway, when the dam is viewed looking downstream, is situated nearest to the Rapide Croche lock. The spillway measures 152 feet 3 inches in length and is defined by the portion of the dam between the abutment at the northwestern most end of the dam and the northwestern most sluice pier. This section of the spillway consists of three 48 foot 9 inch spillway sections divided by two 3 foot wide walk piers.<sup>26</sup>

The northwestern or left spillway of the Rapide Croche dam is attached to the left dam abutment. The abutment is constructed of reinforced concrete poured in three sections. Each section rests on a poured concrete slab attached to bedrock.<sup>27</sup>

The center abutment section rests on an 8 foot thick slab of concrete 12 feet wide and 23 feet 6 inches long. The center section rises 14 feet above the upper surface of the base to reach an elevation of 614.30 feet above sea level. The center abutment section is 23 feet 6 inches long and is aligned parallel with the left-most spillway construction section. The northernmost abutment section and base is identical to the center section but is angled outward from the dam at an angle of

10°. The southern abutment section rests on a 3 foot 8 inch slab that is 12 feet wide and 24 feet long. The abutment rises 14 feet from the upper surface of the slab to reach an elevation of 610.30 feet above sea level. Four 12 inch risers step up the northernmost end of the abutment to match the surface elevation of the center abutment. The southernmost section is angled outward from the dam at an angle of 10°. All three abutment sections are attached to one another by concrete mortise and tenon joints that extend the full height of each section. A reinforced concrete cut-off extends outward from the center abutment section 12 feet landward from the dam. The cut-off wall is 4 feet wide at the base and tapers upward to narrow to 3 feet at the wall's top.<sup>28</sup>

The left spillway consists of 10 poured concrete construction sections. Each construction section is 15 feet 3 inches wide, save the section closest to the sluiceway, which is 15 feet wide. Each construction section is anchored to the bedrock by four 1 inch by 1 foot 6 inch anchor bolts grouted into the rock and spaced every 3 feet 8 1/4 inches across the width of the section. In addition to the anchor bolts, a 4 foot wide, 2 foot deep concrete key, extends the entire length of the dam. The key is anchored by two 1 inch by 4 foot iron bars spaced every 1 foot 6 inches and one 1 1/2 inch by 4 foot split dowel, inserted 1 foot 6 inches into the bedrock, at intervals of 4 feet.<sup>29</sup>

The first nine northwestern most construction sections are each 15 feet 3 inches in wide. The right most section is tied to the abutment with a 5 1/2 inch deep 1 foot 11 inch wide concrete key, that extends the full height of the section. A 3/8 inch by 1 foot cutoff plate is inserted into the keyway to further strengthen the abutment. The southeastern most section of the left spillway is tied to the first sluice pier and is 15 feet wide. This section is tied to the sluice pier with ten 1 inch by 3 foot stub bolts screwed into sleeve nuts.<sup>30</sup>

Aside from differing widths, each construction section of the left spillway conforms to specifications of a generalized construction section plan. When measured parallel to the river channel, each construction section has a basal length of 23 feet 6 inches. The upstream face of the left spillway is perpendicular to the flat river bottom for the first 10 feet 6 inches of its height. At this point it describes an arc with a 4 foot radius until it reaches the crest elevation of 603.85. The downstream face of the east spillway, extends 21 feet 6 1/2 inches from the crest line to the downstream edge and is constructed as a compound curve consisting of four tangential circles with radii of 12 feet, 27 feet, 7 feet 6 inches, and 4 feet.<sup>31</sup>

When measured from the rock bottom of the Fox River, each construction section of the left spillway is approximately 12 feet high at the crest line. The crest line is the highest point of the spillway, maintaining an elevation of 603.85 feet above sea level. By comparison, the downstream "toe" of the spillway rises about 2 feet 6 inches above the river bottom, maintaining an elevation of 594.35 feet above sea level.<sup>32</sup>

The spillway construction sections are secured by a concrete mortise and tenon joint running the full height of each spillway section. The tenon, slightly beveled from a 23 inch width at its widest to a 21 inch width at its leading edge, is secured in a 5 1/2 inch deep mortise in the adjoining construction section. The seams between each spillway section are filled by 1/8 inch thick construction joints, with 1/8 inch thick expansion joints at every third joint. At each expansion joint, a 1/32 inch by 15 inch soft copper sheet runs the entire height of the concrete mortise and tenon joint.<sup>33</sup>

Reckoned from the abutment end of the left spillway, the 4th, 7th, and 10th or last section of the spillway support concrete piers which serve as a base for a metal walkway running the length of the spillway.<sup>34</sup> The last or 10th section of the spillway is anchored to the left most sluice pier of the central sluiceway. The pier on the fourth section has a longitudinal center that is 4 feet 6 inches

from the northwestern edge of the spillway construction section. The walkway pier on the seventh construction section has a longitudinal center that is 10 feet 6 inches from the northwestern edge of the section.<sup>35</sup>

The two smaller walk piers of the left spillway are bullet shaped, with the parabolic end pointing upstream. The walk piers measure 9 feet from the tip of the parabolic end to the downstream edge. Measured from the downstream side, the pier sections maintain a maximum width of 3 feet for a length of 6 feet, at which point the sides begin to curve gently toward the tip of the parabola. Each side of the pier arches toward the upstream tip, maintaining a curve with a 5 foot circular radius.<sup>36</sup> The upstream nose of the walk piers is armored with a 6 foot section of 4 by 4 by 3/8 inch angle iron secured to the pier with 3/4 inch by 18 inch steel bolts.<sup>37</sup>

The walk piers are tied to the spillway construction sections by two concrete keys, a triangular key located at the upstream end of the pier, and a square key located at the downstream end.<sup>38</sup> Each side of the upstream key is approximately 2 feet, forming an equilateral triangle which points upstream.<sup>39</sup> The base of the triangle is located 3 feet 6 inches from the upstream tip of the walk pier. The long axis of the triangular key is aligned with the longitudinal centerline of the pier section. The center of the square key is located approximately 2 feet from the downstream end of the pier section. The key measures 2 feet on each side, and is centered on the longitudinal axis of the pier. Each key extends into the spillway construction section to a depth of 6 inches. In addition to the concrete keys, each walk pier is tied to the spillway construction section upon which it sits with 17 sections of 3/8 inch diameter rebar. The rebar sections are spaced 16 inches center to center from one another, 3 inches inside the outer dimensions of the pier.<sup>40</sup>

In profile, the walk piers are somewhat rectangular, with concave bottoms conforming to the curved surfaces of the spillway construction sections. The piers were designed to maintain an elevation of 614.3 feet above sea level at their tops, so although the sides of the piers average 11 feet in height, the difference in elevation at the top of the pier from the 614.3 foot elevation varies. On the downstream end of the pier three 12 inch steps carry the elevation from 614.3 to 611.3 feet above sea level.<sup>41</sup>

A walkway spans the entire length of the left spillway from the dam abutment to the first pier section of the sluiceway. The walkway over the left spillway consists of six sections of channel iron bolted onto the walk pier sections with 3/4 inch by 18 inch split anchor bolts fitted with specially beveled washers.<sup>42</sup> Each side of the walkway is constructed of three channel beams bolted end to end, and spaced 3 feet 5 1/4 inches apart so that the channels of opposite beams face one another. The interior space between the channel beams is spanned by 3 foot 4 inch lengths of I beams which have been bolted to the channel iron using L braces made of 2 inch sections of 6 by 4 by 3/8 inch angle iron and 1/2 inch by 1 1/2 inch machine bolts. The horizontal I beam sections serve as support ribs spaced 8 feet 7 1/2 inches apart center to center along the entire length of the spillway.<sup>43</sup>

On the exterior of the channel beams, sections of angle iron have been spaced at 17 foot 3 inch intervals the length of the spillway to form the uprights for a handrail. The handrail uprights for the left spillway are constructed of 4 foot sections of 2 1/2 by 2 1/2 by 1/4 inch angle iron. A taller upright, 4 feet 5 3/8 inches in height, is located at the sluiceway end of the left spillway. From this and the adjacent upright, two 3.5 foot long 2 1/2 by 2 1/2 by 1/4 inch braces angle from 3 feet below the top of the uprights to the channel iron. The braces are fastened to 11 by 9 1/2 by 3/8 inch plates, which fasten to the channel iron. The last upright of the spillway walkway is connected to the first upright of the sluiceway walkway by two sections of 3 foot 8 9/16 inch long pieces of 2 1/2 by 2 1/2 by 1/4 inch angle iron to form a railing between the two walkways.<sup>44</sup>

The walkway uprights are spaced so that the bolts used to secure the horizontal I beam sections to the interior of the channel beam also serve as the lower of two bolts used to secure the uprights to the exterior of the beam. The second bolt used to secure the upright to the channel beam is located 9 inches above this lower bolt. On each side of the left spillway walkway, two 156 foot lengths of 1/2 inch galvanized 7 strand Siemens-Martin wire rope has been threaded through holes drilled in the walkway uprights. The upright holes are located 2 feet 3 inches and 3 feet 9 inches from the base of the walkway channel beam. The ends of the wire rope have been looped and secured with three bolt and guy clamps, and connected to 3/4 inch eye bolts fastened to 3/4 inch turnbuckles.<sup>45</sup>

The decking of the spillway walkway is made up of 18 foot long sections of 3 inch by 12 inch planking laid three across, 1 inch apart and 2 inches from the web of the channels, to cover the span between the channel beams.<sup>46</sup> The planking has been nailed onto 3 foot 3 inch sections of 4 inch by 4 inch beams which are bolted to the tops of the horizontal I beam sections spanning the interior space between the channel beams.<sup>47</sup>

### Right Spillway

The right (when viewed looking downstream) spillway is similar to the left spillway. The major difference between the two spillways is that the right is noticeably longer than the left spillway, extending to an overall length of 204 feet. The right spillway is defined by the portion of the dam between the power house on the southeastern end of the dam and the southeastern most sluice pier. This section of the dam consists of four 48 foot 9 inch spillway sections divided by three 3 foot wide walkway piers.<sup>48</sup>

The right spillway is constructed of 14 poured concrete construction sections, each one being 14 feet 9 inches wide, with the exception of the section at each end.<sup>49</sup> The section at the southeastern end, which is tied to a privately owned hydroelectric facility by 1 inch by 7 foot dowels, is 11 feet 6 inches wide; the section at the northwestern end of the right spillway, is tied to the first sluice pier with ten 1 inch by 3 foot stub bolts screwed into sleeve nuts and is 15 feet 6 inches wide.<sup>50</sup>

Each construction section is anchored to the bedrock by four 1 inch by 1 foot 6 inch anchor bolts grouted into the bedrock and spaced every 3 feet 8 1/4 inches across the width of the section.<sup>51</sup> In addition to the anchor bolts, a 4 foot wide concrete key set into a 2 foot deep keyway, extends the entire length of the dam. The concrete key is attached to the keyway by paired 1 inch by 4 foot iron bars spaced every 1 foot 6 inches and one 1 1/2 inch by 4 foot split dowel, spaced 4 feet apart the length of the dam.<sup>52</sup> The iron bars and split dowels are grouted into the underlying bedrock

Aside from the differing widths, each construction section of the right spillway conforms to specifications of a generalized construction section plan. When measured parallel to the river channel, each construction section has a basal length of 23 feet 6 inches. The upstream face of the right spillway is perpendicular to the river bottom for the first 10 feet 6 inches of its height. At that point it begins to describe an arc with a 4 foot radius that curves upward to reach the crest elevation of 603.85. The radius is measured to the vertical crest line, which is 2 feet 11 1/2 inches downstream from the upstream face of the dam. The downstream face of the right spillway, measuring 21 feet 6 1/2 inches horizontally from the crest line to the downstream edge, is constructed as a compound curve consisting of four tangential arcs with radii of 12 feet, 27 feet, 7 feet 6 inches, and 4 feet.<sup>53</sup>

When measured from the rock bottom of the Fox River, each construction section of the right spillway is approximately 12 feet high at the crest line. The crest line is the highest point of the spillway, maintaining an elevation of 603.85 feet above sea level. By comparison, the

downstream "toe" of the spillway measures about 2 feet 6 inches from the elevation of the river bottom, maintaining an average elevation of 594.35 feet above sea level.<sup>54</sup>

The spillway construction sections are secured by a concrete mortise and tenon joint running the full height of each spillway section. The tenon, slightly beveled from 23 inches to 21 inches is secured in a 5 1/2 inch deep mortise in the adjoining construction section. The seams between each spillway section are filled by 1/8 inch thick construction joints, with 1/8 inch expansion joints at every third joint. At each expansion joint, a 1/32 inch by 15 inch soft copper sheet runs the entire height of the concrete mortise and tenon joint.<sup>55</sup>

Beginning at the northwestern end of the right spillway, the 4th, 7th, and 11th construction sections support concrete piers which serve as a base for a metal walkway running the length of the spillway. The piers are situated differently relative to the axial center of each base section. The pier on the fourth construction section is centered 5 feet 3 inches from the northwest edge of the section. The pier on the seventh construction section is centered 12 feet 9 inches from the northwest edge of the section. Finally, the pier on the 11th section is centered 5 feet 6 inches from the base's northwest edge.<sup>56</sup>

The walk piers of the right spillway are bullet shaped, with the parabolic end pointing upstream. Each pier measures 9 feet from the tip of the parabolic end to the downstream edge. Measured from the downstream side, the pier sections maintain their maximum width of 3 feet for a length of 6 feet, at which point the sides begin to curve gently toward the tip of the parabola. Each side of the pier arches toward the upstream tip, maintaining a curve with a 5 foot circular radius. The upstream nose of each of the walkway piers is armored with a 6 foot section of 4 by 4 by 3/8 inch angle iron secured onto the pier with 3/4 inch by 18 inch steel bolts.<sup>57</sup>

The walk piers are tied into the spillway construction sections by two concrete keys, one at the upstream end of the pier, and a second located at the downstream end. Each side of the upstream key is approximately 2 feet, forming an equilateral triangle which points upstream. The base of the triangle is located 3 feet 6 inches from the upstream tip of the walk pier. The long axis of the triangular key is aligned with the longitudinal center of the pier section. The center of the downstream key is located approximately 2 from the downstream end of the pier section. The key measures 2 feet on each side, and is centered on the longitudinal axis of the pier. Each key extends into the spillway construction section to a depth of 6 inches. In addition to the concrete keys, each walk pier is tied into the spillway construction section upon which it sits with 17 sections of 3/8 inch diameter rebar. The rebar sections are spaced 16 inches center to center, 3 inches inside the outer dimensions of the pier.<sup>58</sup>

In profile, the walk piers are somewhat rectangular, with concave bottoms conforming to the curved surfaces of the spillway construction sections. The piers were designed to maintain an elevation of 614.3 feet above sea level at their tops, so although the piers average 11 feet in height, the difference in elevation of the tops of the pier from the 614.3 foot elevation varies. On the downstream end of the pier three 12 inch risers carry the elevation from 614.3 to 611.3 feet above sea level.<sup>59</sup>

A walkway spans the entire length of the right spillway from the southeastern most pier section of the sluiceway to the privately owned power house. The walkway over the right spillway consists of a total of eight 15 inch sections of channel iron bolted onto the walk pier sections with 3/4 inch by 18 inch split anchor bolts fitted with specially beveled washers.<sup>60</sup> Each side of the walkway is comprised of four channel beams bolted end to end, and spaced 3 feet 5 1/4 inches apart so that the channels of opposite beams face one another. Starting from the sluiceway, working toward the power house, the lengths of the channel iron are: 51 feet 8 3/4 inches, 51 feet 8 1/2 inches, 51 feet

8 1/2 inches, and 52 feet 2 1/2 inches. The interior space between the channel beams is spanned by 3 foot 4 inch long I beams which have been bolted to the channel iron using L braces made of 2 inch sections of 6 by 4 by 3/8 inch angle iron and 1/2 inch by 1 1/2 inch machine bolts. The horizontal I beam sections serve as support ribs spaced 8 feet 7 1/2 inches apart center to center along the entire length of the spillway.<sup>61</sup>

On the exterior of the channel beams, sections of angle iron have been spaced at 17 foot 3 inch intervals the length of the spillway to form the uprights for a handrail. The handrail uprights for the right spillway are constructed of 4 foot sections of 2 1/2 by 2 1/2 by 1/4 inch angle iron. A taller upright, 4 feet 5 3/8 inches in height, is located at the sluiceway end of the right spillway, one upright before attachment with the sluiceway. From this upright, and the one following it, two 2 1/2 by 2 1/2 by 1/4 inch braces 3 feet 6 inches long angle from 3 feet below the top of the uprights to the channel iron. The braces are fastened to 11 by 9 1/2 by 3/8 inch plates, which fasten to the channel iron 2 feet 7 1/2 inches and 3 feet 7 1/2 inches toward the power house, from the last upright. The last upright of the spillway walkway is connected to the first upright of the sluiceway walkway by two sections of 3 foot 8 9/16 inch long pieces of 2 1/2 by 2 1/2 by 1/4 inch angle iron that form a railing between the two walkways.<sup>62</sup>

The walkway uprights are spaced so that the bolts used to secure the horizontal I beam sections to the interior of the channel beam also serve as the lower of two bolts used to secure the uprights to the exterior of the beam. The second bolt used to secure the upright to the channel beam is located 9 inches above this lower bolt. On each side of the right spillway walkway, two 206 foot lengths of 1/2 inch galvanized 7 strand Siemens-Martin wire rope has been threaded through holes drilled in the walkway uprights. The upright holes are located 2 feet 3 inches and 3 feet 9 inches from the base of the walkway channel beam. The ends of the wire rope have been looped and secured with three bolt guy clamps, and connected to 3/4 inch eye bolts fastened to 3/4 inch turnbuckles.<sup>63</sup>

The decking of the spillway walkway is made up of 18 foot sections of 3 inch by 12 inch planking laid three across, 1 inch apart to cover the span between the channel beams.<sup>64</sup> The planking has been nailed onto 3 foot 3 inch sections of 4 inch by 4 inch beams which are bolted to the tops of the horizontal I beam sections spanning the interior space between the channel beams.<sup>65</sup>

In addition to the walkway over the right spillway, a walkway extends along the powerhouse on the southeastern end of the dam. This walkway consists of two 25 foot long sections of channel iron laid on top of the channel iron of the right spillway walkway.<sup>66</sup> Each side of the walkway is comprised of one section of 25 foot channel iron spaced 3 feet 2 inches apart so that the channels of the beams face each other. The interior space between the channel beams is spanned by 3 foot 5 1/2 inch lengths of I beams which have been bolted to the channel iron using L braces made of 2 inch sections of 6 by 4 by 3/8 inch angle iron. The I beams run 4 inches into the power house wall, anchoring the walkway, along with 15 inch long 3/4 inch anchor bolts. The horizontal I beam sections serve as support ribs spaced 6 feet 4 inches apart center to center along the length of the walkway.<sup>67</sup>

On the exterior of the channel beams, sections of angle iron extend the length of the walkway on the side opposite the power plant to form the uprights for a handrail. All of the uprights are 2 1/2 by 2 1/2 by 1/4 inches angle iron but vary in length and spacing. Although the uprights are of different lengths, all have a top elevation of about 619.425 feet above sea level.<sup>68</sup>

The walkway uprights are spaced so that the bolts used to secure the horizontal I beam sections to the interior of the channel beam also serve as the lower of two bolts used to secure the uprights to the exterior of the beam. The power house walkway is covered with planking attached to horizontal nailing strips.<sup>69</sup>

### Sea Lamprey Barrier

Both the left and right spillways of the Rapide Croche dam were modified to support a poured concrete sea lamprey barrier. The modifications were designed to prevent the entry of sea lamprey into the Lower Fox River from upstream locations such as Green Bay.

Modifications included: (1) removal of concrete from the existing spillway monoliths in order to allow secure attachment of the barrier; (2) installation of steel anchor bars; and (3) installation of the poured concrete barrier. Approximately 8 inches to 24 inches of concrete was removed from the downstream surface of the spillway in order to produce flat, level surfaces to which the barrier could be attached.<sup>70</sup>

A 12 inch wide, 4 inch deep keyway was cut into the lower spillway face to serve as an anchor for the downstream end of the sea lamprey barrier. In addition, the lower face of the spillway was cleaned and scarified. Three rows of #7 steel anchor bars were grouted into the prepared surface of the spillway. Anchors were spaced at 3 foot intervals the entire length of the spillway.<sup>71</sup>

The sea lamprey barrier consists of a poured concrete shelf reinforced with steel rebar. The 6 foot 8 inch long upper surface of the barrier is level and set flush with the upper spillway surface approximately 1/2 inch below the crest line elevation. The downstream face of the barrier is planked vertical to extend about 2 feet 3 inches above the surface of the spillway. A tee-shaped iron beam (wt 8 by 25) is attached to the barrier with the long arm of the tee flush with the upper downstream face of the barrier to provide a 3 inch overhang projection outward from the vertical downstream face of the barrier.<sup>72</sup> It is this projection which prevents sea lamprey from ascending the spillway and gaining entrance to the Lower Fox River.

### Sluiceway

The sluiceway section of the Rapide Croche dam is located between the left and right spillway sections, 152 feet 3 inches southeast of the left abutment, and 204 feet northwest of the privately owned hydroelectric facility.<sup>73</sup> The overall length of the sluiceway is 105 feet. The sluiceway is comprised of five poured concrete construction sections, and five 5 foot wide sluice piers. Each sluiceway construction section is anchored to the bedrock of the river bottom by four rows of 6 steel split bolts spanning the width of the section, 4 feet apart. The first row of bolts are 4 feet 6 inches long and are located 4 feet from the upstream edge of the section; the next row consists of 4 foot long bolts fastened 5 feet 6 downstream from the first set. The final two rows are spaced at 7 foot intervals. The bolts in the third row are 3 feet 6 inches long, while those comprising the fourth row are 2 feet 6 inches long. The first three rows are grouted 18 inches into the bedrock, while the fourth row is grouted 12 inches deep. One foot on either side of the first row, are seventeen 1 inch by 4 foot 6 inch lengths of rebar spaced 18 inches apart to further strengthen the sections. The spillway construction sections are also anchored to the bottom by a 4 foot wide concrete key, poured into a trench cut at a minimum depth of 2 feet into the bedrock the entire length of the spillway. Additional reinforcement is provided by 1 inch by 4 foot 6 inch upright sections of rebar which are spaced at 18 inch intervals in two rows 2 feet apart the entire length of the key. Final anchoring is provided by two rows of 3/8 inch diameter rebar, one on the upstream end, the other on the downstream end. The rebar is 12 feet long on the upstream end, and 18 inches long on the downstream end.<sup>74</sup>

The construction sections of the sluiceway conform to the specifications of a generalized construction section plan. With the exception of the 15 foot wide sections at the extreme ends of the sluiceway, each of the construction sections is 25 feet wide. Measured parallel to the river channel, each section has a basal length of 28 feet.<sup>75</sup>

Somewhat ramp-shaped in profile, the sluiceway construction sections have a maximum height of 3.1 feet above the average elevation of the river bottom, or 595.5 feet above mean sea level. From an upstream height of 2.1 feet above the average elevation of the river bottom, the sluiceway sections slope up to achieve the 3.1 feet height at a horizontal distance of 4 feet from the upstream end. The 3.1 foot thickness is maintained for a horizontal distance of 8 feet, at which point the section begins to slope gently downstream to a height of 1.6 feet above the average elevation of the river bottom at the extreme downstream edge, or 594.0 feet above mean sea level.<sup>76</sup>

The sluiceway construction sections are secured together with lengths of 1 inch diameter rebar which extend the width of the section and are spaced at 15 inch intervals. Additional 12 foot lengths of 3/8 inch diameter rebar have been placed longitudinally across the section, spaced at 2 foot intervals. The seams between sluiceway construction sections are filled by construction joints.<sup>77</sup>

The sluiceway construction sections of the Rapide Croche dam serve as foundations for a series of five upright piers which not only support a sluiceway walkway, but also contain the gate pins on which the sluiceway taintor gates are hung. Three of the sluiceway piers are located along the centerlines of construction sections, while the two end piers are located at the extreme ends of the southeastern and northwestern sections.<sup>78</sup> Four sluiceway openings are created by the placement of the pier sections.

The sluiceway piers are 28 feet in length, and measure 5 feet in width. The upstream ends of the piers are parabolic in shape, curved along a radius of 6 feet 3 inches. The upstream nose of each of the piers is armored with a 20 foot 6 inch long section of 4 by 4 by 3/8 inch angle iron secured onto the pier with 3/4 inch by 18 inch steel bolts. Sluiceway pier heads measure 4 feet 4 inches from the parabolic tip of the upstream end to the downstream edge. Immediately posterior of the pier heads is a "stop log" slot which runs the entire height of the pier section. The stop log slots, which are 6 inches deep and 13 inches wide, are located in pier faces interior of sluiceway openings. The downstream corners of the stop log slots have been armored with 20 foot 6 inch long sections of 4 by 4 by 3/8 inch angle iron secured onto the pier face with 3/4 inch by 18 inch steel bolts.<sup>79</sup>

The sluiceway piers are tied into the sluiceway construction sections by two rectangular concrete keys, sections of rebar, and anchor bolts. Both concrete keys extend 6 inches from the top of the sluiceway sections into the bottom of the pier sections. The first key, located on top of the horizontal section of the sluiceway construction section, measures 6 feet in length and 2 feet wide. The key is secured to the sluiceway construction section by two rows of 3/4 inch diameter by 3 foot 6 inch rebar spaced 1 foot 10 inches apart. The second key, located on top of the slanted downstream section of the sluiceway construction section, is 10 foot in length and 2 feet in width. It is secured to the sluiceway construction section with 12 sections of 3/4 inch by 3 foot 6 inch long rebar in two rows set 1 foot 10 inches apart. In addition to the concrete keys, each sluiceway pier is tied into the construction sections with 3/8 inch diameter rebar.<sup>80</sup>

In profile, the sluiceway piers are rectangular, with the upstream portion stepped up by six 16 inch risers above the rest of the pier section. The piers have concave bottoms conforming to the curved surfaces of the spillway construction sections.<sup>81</sup> The tops of the upstream portion of the piers reach an elevation of 616.0 feet above sea level, while the downstream portions maintain an elevation of 608.0 above sea level.<sup>82</sup> The upstream ends of the sluiceway piers rise 21 feet 6 inches above the tops of the sluiceway construction sections and the downstream ends are 14 feet above the surface of the sections.<sup>83</sup>

Fifteen foot, 6 inch high steel taintor gates are located within each of the sluiceway openings. The taintor gates are hung on a 6 foot 8 inch long, 6 inch diameter cold rolled steel gate pin by a cast steel gate hinge.<sup>84</sup> Each gate is connected to the gate hinges by end girders and bracing constructed of 8 by 8 by 3/4 inch angle iron. The upper and lower arms of the end girders are 16 foot sections of angle iron fastened to the gate hinges with 7/8 inch diameter rivets. The upper and lower arms of the taintor gate end girders form the sides of an isosceles triangle with a 40° angle located at the gate hinge. The arms of the end girders are braced with three sections of triangulated 3 by 3 by 3/8 inch angle iron. Two of these angle iron sections are also connected to a 3/8 inch thick steel web plate which spans the space between the upper and lower arms directly behind the taintor gate face. The space between gate end girders is spanned by sections of channel iron running the width of the gate and connecting the upper and lower arms of opposite gate end girders. Additional bracing between girders is located 4 feet 6 1/4 inches behind the gate face at the top and bottom of the gate. A 3/8 inch thick steel web plate is located directly behind the gate face at the centerline of the gate. This web is tied to the horizontal gate bracing by two 4 foot 6 1/4 inch sections of 3 by 3 by 3/8 inch angle iron.<sup>85</sup>

The front of each sluiceway gate is faced with 3/8 inch thick steel plates secured to the gate bracing and web plates by 8 inch horizontal I beams. Seams between the plates are secured by 6 inch wide strips of 3/8 inch steel plate which run the entire height of the taintor gate. A 20 foot long 8 inch by 8 inch oak beam is bolted to the channel iron running along the foot of the gate, providing a sill for the gate.<sup>86</sup>

The sluiceway gates of the Rapide Croche dam are operated by a "crab", a mechanism containing a pair of electric winches that moves from gate to gate along a track on top of the sluiceway.<sup>87</sup> The crab is constructed of two 21 foot lengths of channel iron connected parallel to each other by four sections of 2 foot 2 1/2 inch I beam iron.<sup>88</sup> The crab winches are powered by a five horsepower open type wound rotor motor mounted at the middle of the crab frame. A winch hand wheel is also located near the middle of the crab frame. The crab mechanism rides along a 3 foot 8 inch gauge track mounted along the downstream length of the sluiceway.<sup>89</sup>

In order to raise or lower a gate, the crab is positioned over the gate, and the winch chains are connected to the hoist chain connections on the gate.<sup>90</sup> Once positioned, the crab is connected to a power source, and the winches are turned on until the gate has been raised to the desired height. Once this height is reached, the crab is disconnected from the power source and moved to the next gate to be opened.<sup>91</sup> The electric winches are capable of lifting the gate at a rate of 2 feet per minute. In contrast, 61.5 revolutions of the hand wheel are required to lift the gate 1 foot.<sup>92</sup>

When not in use, the crab mechanism is housed in a wooden structure built over the span between the two northwesternmost sluiceway piers.<sup>93</sup> The gate hoist house is built on top of two 22 foot 4 inch horizontal timbers spanning the space between the sluiceway piers. Along the upstream side of the gate hoist house, a 4 inch by 4 inch sill plate has been bolted directly to the top of the sluiceway walkway planking. The sill plate on the downstream side of the crab house is a 4 inch by 8 inch beam bolted 1 foot 3 inches above the top of the sluiceway pier section. At each end of the sill plates, 4 inch by 4 inch wall studs are fastened directly to the sill plate. Between these beams, 2 inch by 4 inch studs have been spaced 2 feet apart, center to center.<sup>94</sup> On top of the 4 inch by 4 inch wall studs, two 2 inch by 4 inch beams have been strung to form the top plate.

A 2 foot 8 inch wide personnel door is located on the spillway end of the crab house. A set of double doors on the sluiceway side of the crab house allow the crab to be moved along its track and positioned at the gates. The upstream and downstream sides of the crab house each contain a single window located in the center of the wall. The crab house is covered with a moderately pitched, front-gabled asphalt shingle roof.<sup>95</sup>

In addition to the crab house, a steamhouse is located on the northwesternmost sluiceway pier. Constructed in the 1980s, the steamhouse is a pre-fabricated structure manufactured by Armco Building Systems of Cincinnati, Ohio. The modular wall panels, which are bolted directly onto the sluiceway pier, support four 16 inch roof panels.<sup>96</sup> An entrance door is located on the upstream side of the steamhouse, and a single, louvered vent is centered on the downstream side.<sup>97</sup>

A walkway spans the entire length of the sluiceway. The walkway consists of a total of eight sections of channel iron bolted onto the sluiceway pier sections with 3/4 inch by 18 inch split anchor bolts fitted with specially beveled washers.<sup>98</sup> Each side of the walkway is constructed of four channel beams bolted end to end, and spaced 2 feet 7 7/16 inches apart so that the channels of opposite beams face one another. The interior space between the channel beams is spanned by thirteen 2 foot 7 inch lengths of I beams which have been bolted to the channel iron using L braces made of 2 inch sections of 6 by 4 by 3/8 inch angle iron and 1/2 inch by 2 inch machine bolts. The horizontal I beam sections serve as support ribs spaced 8 feet 4 inches apart along the entire length of the walkway.<sup>99</sup>

On the exterior of the channel beams, sections of angle iron have been spaced at 25 foot 11 1/4 inch intervals the length of the sluiceway to form the uprights for a handrail.<sup>100</sup> The sluiceway handrail uprights are constructed of 4 foot sections of 2 1/2 by 2 1/2 by 3/8 inch angle iron.<sup>101</sup>

The walkway uprights are spaced so that the bolts used to secure the horizontal I beam sections to the interior of the channel beam also serve as the lower of two bolts used to secure the uprights to the exterior of the beam. The second bolt used to secure the upright to the channel beam is located 5 inches above this lower bolt. On each side of the sluiceway walkway, two 105 inch lengths of 1/2 inch galvanized 7 strand Siemens - Martin wire rope has been threaded through holes drilled in the walkway uprights. The upright holes are located 1 foot 6 inches and 3 feet 9 inches from the base of the walkway channel beam. The ends of the wire rope have been looped and secured with three guy clamps, and connected to 3/4 inch eye bolts fastened to 3/4 inch turnbuckles.<sup>102</sup>

The decking of the spillway is made up of 25 foot sections of 3 inch by 12 inch planking laid three across and 1 inch apart to cover the span between the channel beams. The planking has been nailed onto 2 foot 4 inch sections of 4 inch by 4 inch beams which are bolted to the tops of the horizontal I beam sections spanning the interior space between the channel beams.<sup>103</sup>

## **RAPIDE CROCHE CANAL**

The Rapide Croche lock is located within an excavated canal that bypasses the Rapide Croche dam to the north, just west of the Village of Wrightstown.<sup>104</sup> The Rapide Croche canal was excavated in 1849-50 following a report made by Wisconsin Board of Public Works engineer Condly R. Alton, who observed rapids at the location and deemed the construction of a canal, dam, and lock necessary.<sup>105</sup>

The Rapide Croche lock canal is oriented generally east/west, and is approximately 2,000 feet in length, including the portion of the canal that lies within the lock.<sup>106</sup> Roughly 225 feet of the canal is upstream of the upper wing walls, 200 feet is within the lock, and 1,475 feet of the canal is downstream from the lower wing walls. The canal varies in width from 100 to 150 feet, with the portion downstream of the lock being generally wider.<sup>107</sup> The canal, which does not exceed 6 feet in depth, has been dredged periodically. There are no special embankment features on either side of the Rapide Croche canal.<sup>108</sup>

## RAPIDE CROCHE LOCK

The Rapide Croche lock consists of a 211 foot 6 inch concrete lock chamber with concrete wing walls at each end. Like the canal, the lock is oriented generally east/west.<sup>109</sup>

The lower wing walls, or those located at the downstream end of the lock, are 29 feet 3 inches high. Each lower wing wall consists of two construction sections tied together by a 6 inch concrete key. Each construction section consists of a 22 foot 6 inch high upper section built on top of a concrete slab measuring 6 feet 9 inches in height and 13 feet in width. The slab is secured to bedrock by two staggered rows of 4 foot sections of 1 1/2 inch split anchor bolts spaced at 4 foot intervals center to center. The upper sections of the lower wing walls are secured to the concrete slab by a 3 foot wide concrete key extending the entire length of the wing wall and intruding 6 inches into the base of the upper section.<sup>110</sup>

The upper sections of the lower wing walls are 10 feet wide at the base, and are tapered to a width of 4 feet at the top. The top of each lower wing wall reaches 614.08 feet above sea level and is stepped down to an elevation of 600.33 feet above sea level by a series of eleven 1 foot 3 inch risers. Each of the lower wing walls is 36 feet in total length. The lower wing walls contain three weep holes which are 6 inches square and 9 feet apart center to center. At the downstream ends of the lower wing walls, an additional support wall is anchored to the bedrock by a 4 foot wide, 12 inch deep key extending the entire width of the wall. The 9 foot long wall slants up to attach to the lowest step of the lower wing walls at an elevation of 600.33 feet above sea level.<sup>111</sup>

The upper wing walls are similar to the lower wing walls, except that they are somewhat more massive, do not have steps, and one is much longer. The easternmost upper wing wall is 36 feet long, but the westernmost upper wing wall is constructed of two sections, with a total length of 49 feet 10 1/8 inches. Both of the upper wing walls are 26 feet 6 inches high and reach a top elevation 615.33. Like the lower wing walls, the upper wing walls consist of a wall section built on top of a concrete slab. The concrete slab base of the upper wing walls is 6 feet 6 inches high, 15 feet wide at base, and is secured to bedrock by two staggered rows of 1 1/2 inch by 4 foot split anchor bolts with square nuts set 4 feet apart. The lower slab is beveled to a width of 13 feet 6 inches at top. Additionally, a 4 foot wide poured concrete key extends 12 inches into the bedrock the entire length of the wing wall. The upper section of the upper wing wall is secured to the concrete slab by a 2 foot wide concrete key which extends the entire length of the wing wall and intrudes 6 inches into the base of the upper section. The upper section of the upper wing wall is 20 feet high, 10 feet wide at the base, and is tapered to a 4 foot width at the top.<sup>112</sup>

The lock chamber of the Rapide Croche lock measures 171 feet from quoin to quoin. Additionally, there is a 28 foot 6 inch upper gate section at the upper end of the lock, and a 12 foot lower gate section at the lower end of the lock which combine to increase the overall length of the lock to 211 feet 6 inches.<sup>113</sup> The upper gate section is defined as that part of the lock structure upstream of the upper gate mitre sill, while the lower gate section is that part of the lock which is downstream from the lower gate mitre sill.

The walls of the upper gate section are longer than the upper gate section itself, extending beyond the upper gate mitre sill and into the actual lock chamber. Spaced 36 feet apart, the upper gate section walls are each 39 feet 6 inches in length. The upper gate section walls are made up of an upper section, and a lower section which serves as a base for the upper section.<sup>114</sup> The base of the upper gate section walls consists of a 39 foot 6 inch long concrete slab which is 18 feet 6 inches wide and 5 feet thick. The top of the concrete slab is elevated 591.83 feet above sea level. The base of the upper gate section is rectangular shaped and rests on the bedrock floor of the lock chamber. The base of the upper gate section walls is tied into the bedrock adjacent to the lock

chamber with 4 foot long sections of 1 1/2 inch diameter anchor bolts with square nuts, set 4 feet apart center to center and imbedded not less than 2 feet into the bedrock.<sup>115</sup>

The upper section of the upper gate section wall is secured to the base with a 4 foot wide concrete key that extends the entire length of the upper gate section and intrudes 6 inches into the bottom of the upper section. The base of the upper section measures 15 feet in width, and is tapered to an 8 foot 8 inch width at the top of the section. The interior face of the upper and lower upper gate walls are aligned flush with one another. Directly behind the lock gates, the interior faces of the forechamber walls are recessed 2 feet 2 inches in order to allow the gates to recess flush when fully opened.<sup>116</sup>

The mechanisms which allow the water level of the lock chamber to be raised are located within the floor of the upper gate section. Six butterfly valves set in groups of three are situated on both sides of the upper gate section immediately outside of the lock gates.<sup>117</sup> When the lock is to be flooded, the lock gates are closed by horizontal spars which connect the inside of the gates to geared vertical shafts enclosed within steel tripods mounted on both sides of the lock wall.<sup>118</sup> A removable bar is inserted in a socketed hub attached to a vertical shaft. The locktender turns the shaft by grasping the removable bar and walking around the tripod. If the gates are to be opened, the locktender walks in a counterclockwise direction; if the gates are to be closed, the locktender walks in a clockwise direction.<sup>119</sup>

When the gate is closed and sealed, the butterfly valves are opened and water is allowed to flow through a culvert below the mitre sill and into the lock.<sup>120</sup> The valves are operated by geared mechanisms connected to hand wheels mounted on top of the lock wall.<sup>121</sup> When opened, the six upstream valves can fill the lock chamber to provide the 8.3 feet of lift required to match the 602.1 feet above sea level elevation of the upper pool in 3 minutes and 8 seconds.<sup>122</sup>

The lower gate section of the Rapide Croche lock consists of two 39 foot 6 inch long concrete sections spaced 36 feet apart from one another.<sup>123</sup> The lower gate section walls consist of an upper section, and a lower section which serves as a base for the upper section. The bases of the lower gate sections are 39 foot 6 inch long concrete slabs. The slabs are 18 feet 6 inches wide and 7 feet thick. The top of the bases are elevated 591.83 feet above sea level. The rectangular shaped bases are tied into the bedrock with 4 foot wide keys that extend 12 inches into the bedrock and span the entire length of the wall.<sup>124</sup>

The upper section of the lower gate wall is secured to the base with a 4 foot wide concrete key which extends the entire length of the lower gate section walls and intrudes 6 inches into the bottom of the upper section. The base of the upper section is 15 feet 4 inches in width, and tapers to an 8 foot 8 inch width at the 23 foot 6 inch high top. The interior faces of the upper and lower sections of the lower gate walls are aligned flush with one another. Directly in front of the downstream lock gates, the faces of each side of the lockwalls are recessed 2 feet 2 inches in order to allow the gates to recess flush when fully opened. When opened, the spars connected to the gate tops pull the gates into the lock chamber.<sup>125</sup>

Six butterfly valves are located in the floor of the lower gate section, set three on each side of the lock. When opened, these valves allow water to flow through a culvert under the lower gate sill to drain the lock.<sup>126</sup> The discharge valves are operated by geared mechanisms connected to hand wheels mounted on top of the lock wall near the lower gate. When opened, the lower valves can discharge the lock chamber to the lower pool elevation in just under 3 minutes.<sup>127</sup>

The lower gates are closed by horizontal spars which connect the inside of the gates to geared vertical shafts mounted on steel tripods located on both sides of the lock wall.<sup>128</sup> A removable bar

is inserted into a socketed hub attached to a vertical shaft and serves as a handle with which to turn the shaft. In order to open or close the gate, the locktender must use the handle to rotate the vertical shaft by walking around the tripod. If the gates are to be opened, the locktender walks in a counterclockwise direction, and if the gates are to be closed, the locktender walks in a clockwise direction.<sup>129</sup>

The lower gates are constructed of 19 foot 2 3/4 inch long 15 inch wide horizontal channel iron beams bolted to 27 foot 10 inch long vertical I beams to form the gate frame.<sup>130</sup> The lower gates are 27 feet 3 inches in height.<sup>131</sup> At the bottom of the gate, a 15 inch 55 pound channel iron is used for the gate sill, and an additional 15 inch 33.9 pound channel iron provides horizontal support at the top of the gate. Between these channel iron beams, horizontal I beams of various gauges have been bolted between the vertical I beams. The first four horizontal supports above the sill plate channel iron are constructed from 75 pound iron, the two above these are made from 60.8 pound iron, and the next three consist of 42.9 pound iron.<sup>132</sup> Including the channel irons at the top and bottom of the gate, there are a total of 11 horizontal support irons on each of the lower gates.

The spacing between the horizontal supports varies according to where each is located on the gate. Where greater rigidity is required, the space between the horizontal supports is decreased. Beginning at the sill plate and moving toward the top of the gate, the spacing between the horizontal I beams is as follows: 2 feet 7 1/8 inches between the sill and the first support; 2 feet 4 inches between the first and second supports; 2 feet 4 1/2 inches between second and third supports; 2 feet 6 inches between the third and fourth, and the fourth and fifth supports; 2 feet 8 inches between the fifth and sixth supports; 2 feet 10 inches between the sixth and seventh supports; 2 feet 11 inches between the seventh and eighth, and the eighth and ninth supports; and 3 feet 4 1/2 inches between the ninth support and the channel iron at the top of the gate.<sup>133</sup>

Between certain rows of the horizontal I beams, lengths of 4 by 3 by 3/8 inch angle iron stiffeners have been placed in five vertical columns to provide additional rigidity to the gate. The lengths of the stiffeners corresponds to the appropriate length necessary to span the space between each of the rows. The stiffener columns are placed between the horizontal rows beginning at the first row above the gate sill plate up to the third row from the top of the gate. The first columns are spaced 3 feet 4 3/8 inches inside both ends of the gate, and the other columns are evenly spaced at 3 foot 1 1/2 inch intervals between these columns.<sup>134</sup>

The spaces between the horizontal I beams and the vertical stiffeners of each gate are filled by 5/16 inch thick steel plating fastened to the frame with 3/4 inch diameter rivets. A diagonal eye bar strung from the upper outside to lower inside corner of the gate and tightened with a turnbuckle supplies additional support and rigidity to the gate.<sup>135</sup>

At the bottom of each of the lower gates, a 5 inch by 8 inch oak beam has been cut to the length of the gate and fitted to the outside of the lower channel iron. At the top of each gate, a 21 foot 2 inch long 1/2 inch by 15 3/4 inch wide oak plank has been fitted to the upper channel iron forming a walkway. On the interior of the lower gate, from the second to the sixth horizontal row below the top, nineteen 3 inch by 10 inch oak plank fenders are hung vertically. These planks provide protection for vessels passing through the lock.<sup>136</sup>

The upper gates are similar to the lower gates, except that they are 19 feet tall and are thus considerably shorter in height.<sup>137</sup> The upper gates are constructed of 19 foot 2 3/4 inch long 15 inch wide horizontal channel iron beams bolted to 15 foot 5 3/8 inch long vertical I beams to form the gate frame.<sup>138</sup> At the bottom of the gate, a 15 inch 55 pound channel iron is used to form the sill plate attachment, and a 15 inch 33.9 pound horizontal channel iron is used as the top gate

support.<sup>139</sup> Between the upper and lower horizontal channel irons, I beams of varying gauges have been bolted to the vertical I beams. The first horizontal support above the channel iron at the sill plate is constructed from 60.8 pound iron, while the remaining three are made of 42.9 pound iron.<sup>140</sup> Including the channel irons at the top and bottom of the gate, there are a total of 6 horizontal support irons on each of the upper gates.

The horizontal supports are spaced at different intervals, depending on location. Where greater rigidity is required, the spacing is decreased. Beginning at the sill plate and moving toward the top of the gate, the spacing between the horizontal I beams is as follows: 2 feet 7 1/8 inches between the sill and the first support; 2 feet 10 inches between the first and second supports; 2 feet 11 inches between the second and third supports and the third and fourth supports; and 3 feet 4 1/2 inches between the fourth support and the channel iron at the top of the gate.<sup>141</sup>

Between certain rows of the horizontal I beams, lengths of 4 by 3 by 3/8 inch angle iron stiffeners have been placed in five vertical columns to provide additional rigidity to the gate.<sup>142</sup> The lengths of the stiffeners corresponds to the appropriate length necessary to span the space between each of the rows. The stiffener columns are placed between the horizontal rows beginning at the first row above the gate sill plate up to the third row from the top of the gate. The first columns are spaced 3 feet 4 3/8 inches inside both ends of the gate, and the other columns are evenly spaced at 3 foot 1 1/2 inch intervals between these columns.<sup>143</sup>

At the bottom of each of the upper gates, a 5 inch by 8 inch oak beam has been cut to the length of the gate and fitted to the outside of the lower channel iron. At the top of each gate, a 21 foot 2 inch long 1/2 inch by 15 3/4 inch wide oak plank has been fitted to the upper channel iron forming a walkway. On the interior of the upper gate, from the top to the first horizontal row above the sill plate, nineteen 3 inch by 10 inch oak plank fenders are hung vertically, to protect vessels during locking.<sup>144</sup>

Each side of the lock chamber located between the upper and lower gate sections consists of five 29 foot 6 inch high concrete construction sections 36 feet long, and tied end to end by 2 foot wide, 6 inch deep concrete keys extending the entire height of each section. Expansion joints fill the seams between each section, and 3/8 inch by 1 foot cut-off plates or 1/32 inch by 1 foot 3 inch soft copper plates extend the entire height of each section, in alternate keyways.<sup>145</sup>

Each of the construction sections which make up the lock chamber wall is made up of two sections, an upper section, and a lower section which serves as a base for the upper section. The base of the lock chamber wall section consists of a 39 foot 6 inch long concrete slab that is 16 feet wide 4 to 6 feet thick. The difference in thickness is attributable to the bedrock on the river bottom being lower on the interior of the lock chamber. The elevation of the top of the base is 592.0 feet above sea level. The base is ell shaped with the 27 inch wide vertical leg extending 12 inches into the bedrock floor of the lock chamber. The base of the lock chamber walls are tied to the bedrock adjacent to the lock chamber with a 4 foot wide concrete key which extends 12 inches into the bedrock.<sup>146</sup>

The upper section of the lock chamber wall construction section is secured to the base with a 4 foot wide concrete key that extends the entire length of the lock chamber base section and intrudes 6 inches into the bottom of the upper section. At its base, the upper section measures 13 feet wide, and is beveled to a 6 foot 6 inch width at the top. The interior face of the upper and lower lock chamber walls are aligned flush with one another.<sup>147</sup>

In the sections immediately adjacent to the upper and lower gate sections, a 2 foot wide ladder is recessed into the interior wall. The rungs of the ladder are constructed from 1 1/4 inch diameter

bars spaced 1 foot 2 inches apart. Also located on the inside face of alternating lock chamber sections are snubbing posts placed in 2 foot by 6 foot openings recessed approximately 2 feet into the lock wall. The snubbing posts are located 32 feet, 78 feet, and 125 feet downstream from the upper quoin and are used to secure lines to the stern and bow of vessels during locking.<sup>148</sup>

The backslopes of all walls are backfilled with clay to the tops of the walls. The lower wing walls were backfilled to 600.33 feet above sea level, while the rest of the structure was backfilled to 615.33 feet above sea level. Backfill around the lower wing wall slopes at a grade of 2V:1H.<sup>149</sup>

## SIGNIFICANCE

The Rapide Croche Lock and Dam Complex is part of the Lower Fox River Waterway System constructed by private companies between 1850 and 1860 and rebuilt by the United States Army Corps of Engineers between 1872 and 1941. Conceived as part of the more extensive Fox River Waterway, the Lower Fox River System operated between Green Bay and Lake Winnebago. The Lock and Dam combination at Rapide Croche allowed navigation around rapids for watercraft traveling between Kaukauna and Green Bay and thus served as an integral part of the operation of the Lower Fox River Waterway System.

## ENDNOTES

- 1 Report of the Board of Public Works Made to the Legislative Assembly, January 19, 1849, p. 5.
- 2 *Ibid.*, p. 18.
- 3 Report of the Board of Public Works Made to the Legislative Assembly, Madison, 1850, p. 27.
- 4 *Ibid.*, p. 27, 35.
- 5 Milwaukee Sentinel, 24 June 1850; 21 August 1850; 12 September 1850.
- 6 Report of the Board, 1850, p. 16.
- 7 Annual Report, 1852:44.
- 8 Milwaukee Sentinel, 6 April 1853.
- 9 *Ibid.*, 14 May 1853; 27 May 1853; 25 June 1853.
- 10 *Ibid.*, 25 June 1853.
- 11 Samuel Mermin, *The Fox-Wisconsin Rivers Improvement: An Historical Study in Legal Institutions and Political Economy*, Madison, 1968, p. 77; Milwaukee Sentinel, 21 June 1856.
- 12 U.S. Congress, Senate, S. Doc. 16, 39th Congress, 2d session, Serial 1278, 7 February 1867, 4-6.
- 13 *Ibid.*, p. 13.
- 14 John N. Vogel, et al., *Lower Fox Corridor Survey*, Menasha, WI: East Central Wisconsin Regional Planning Commission, 1992, p. 85.
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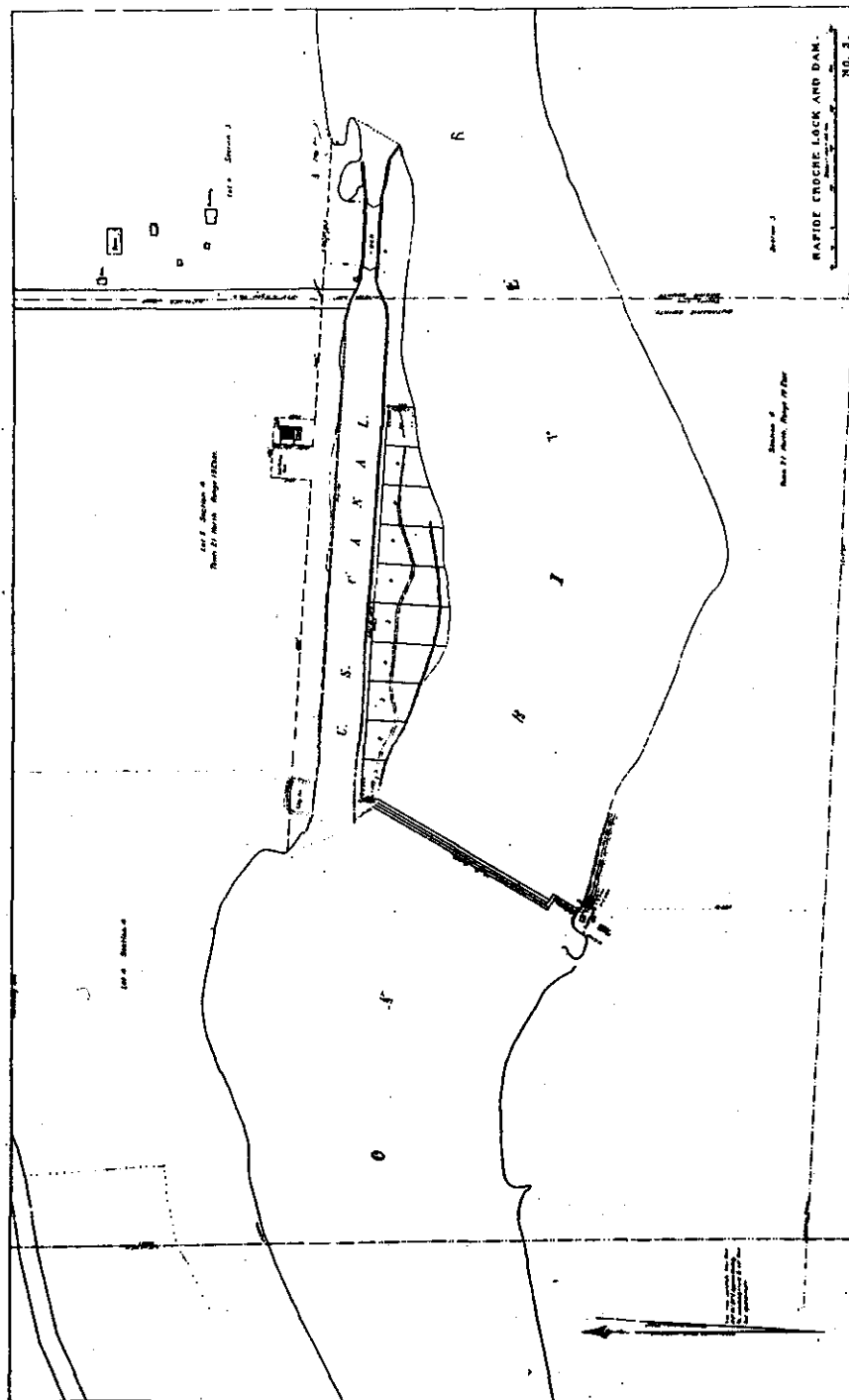
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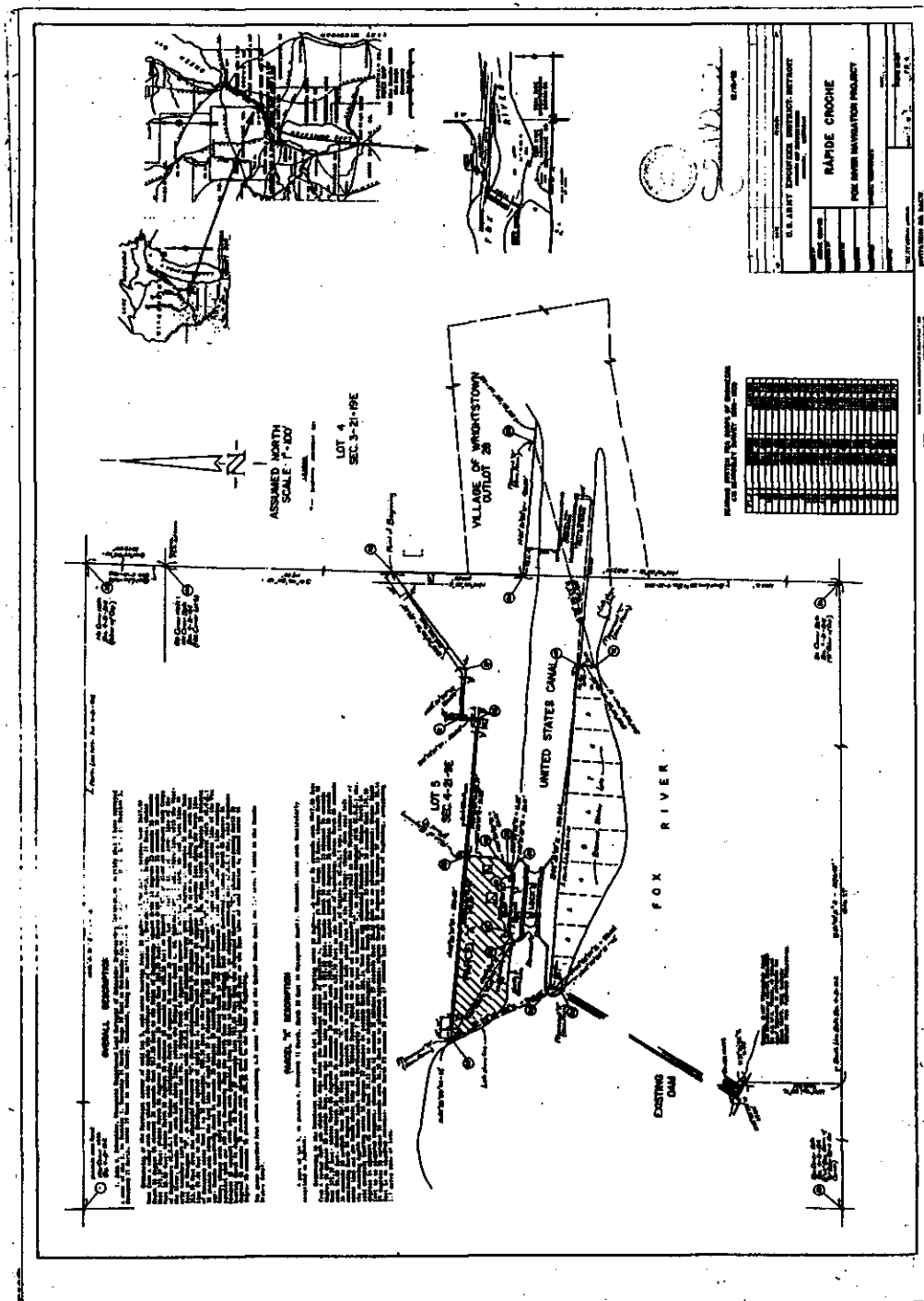
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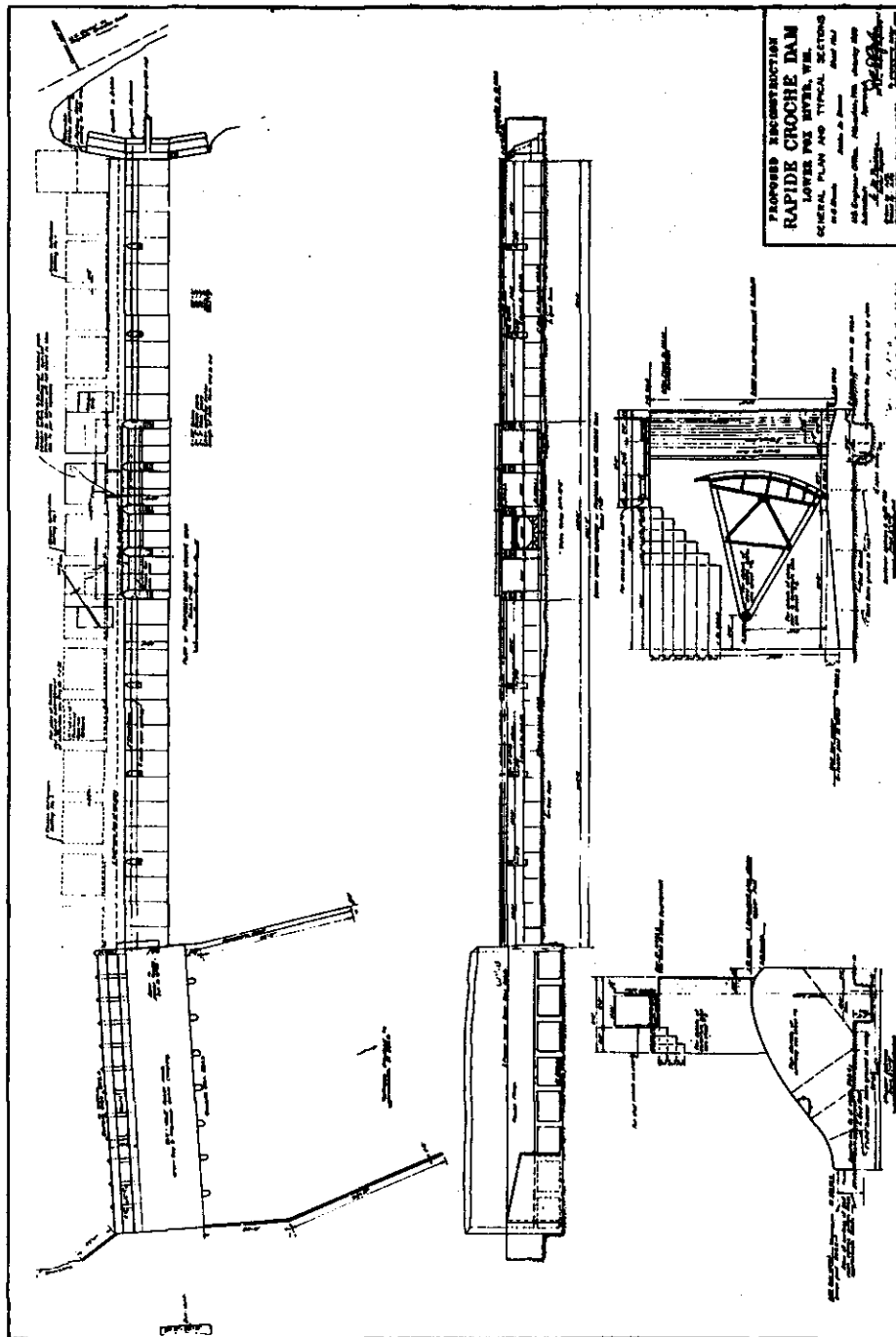
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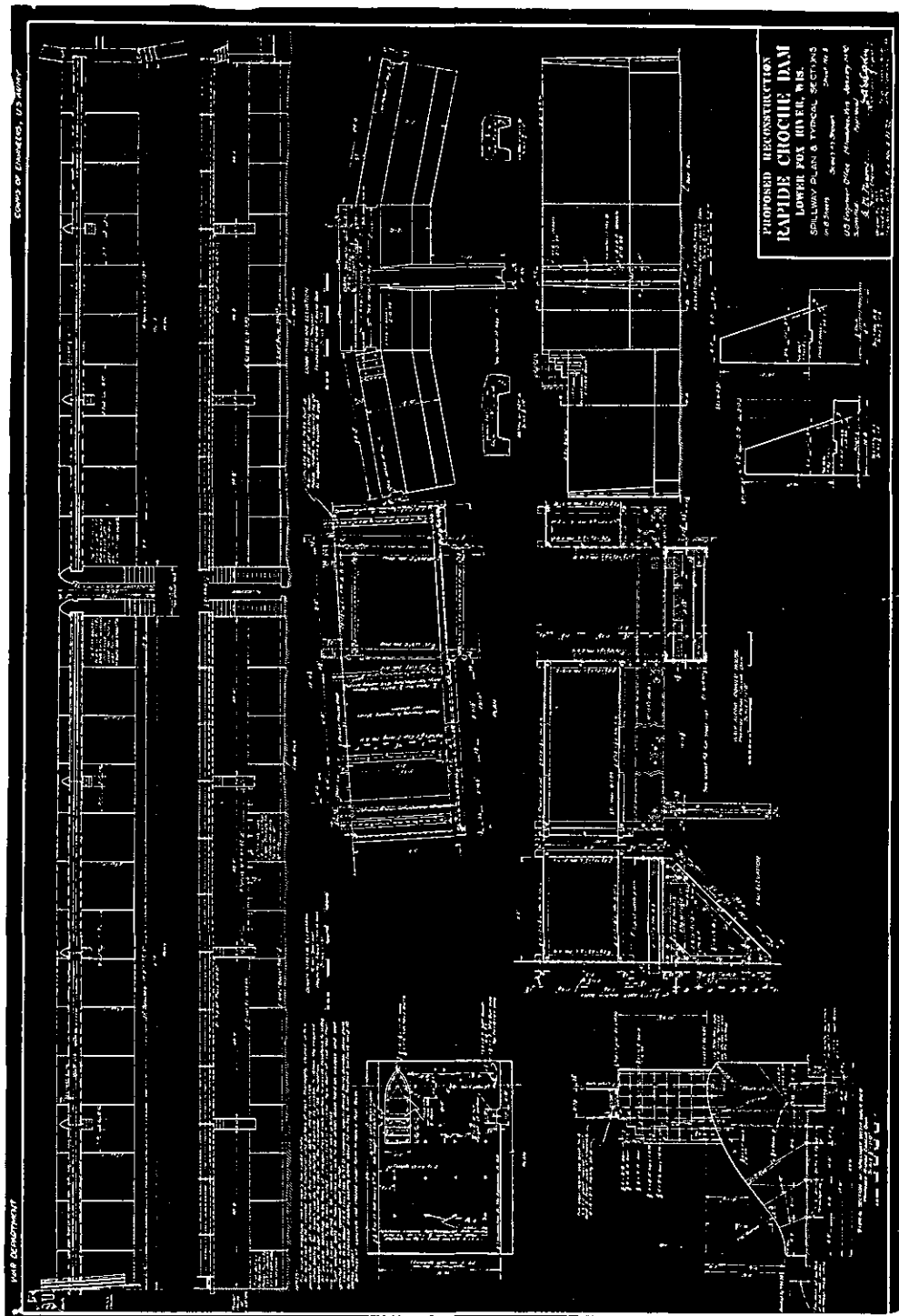
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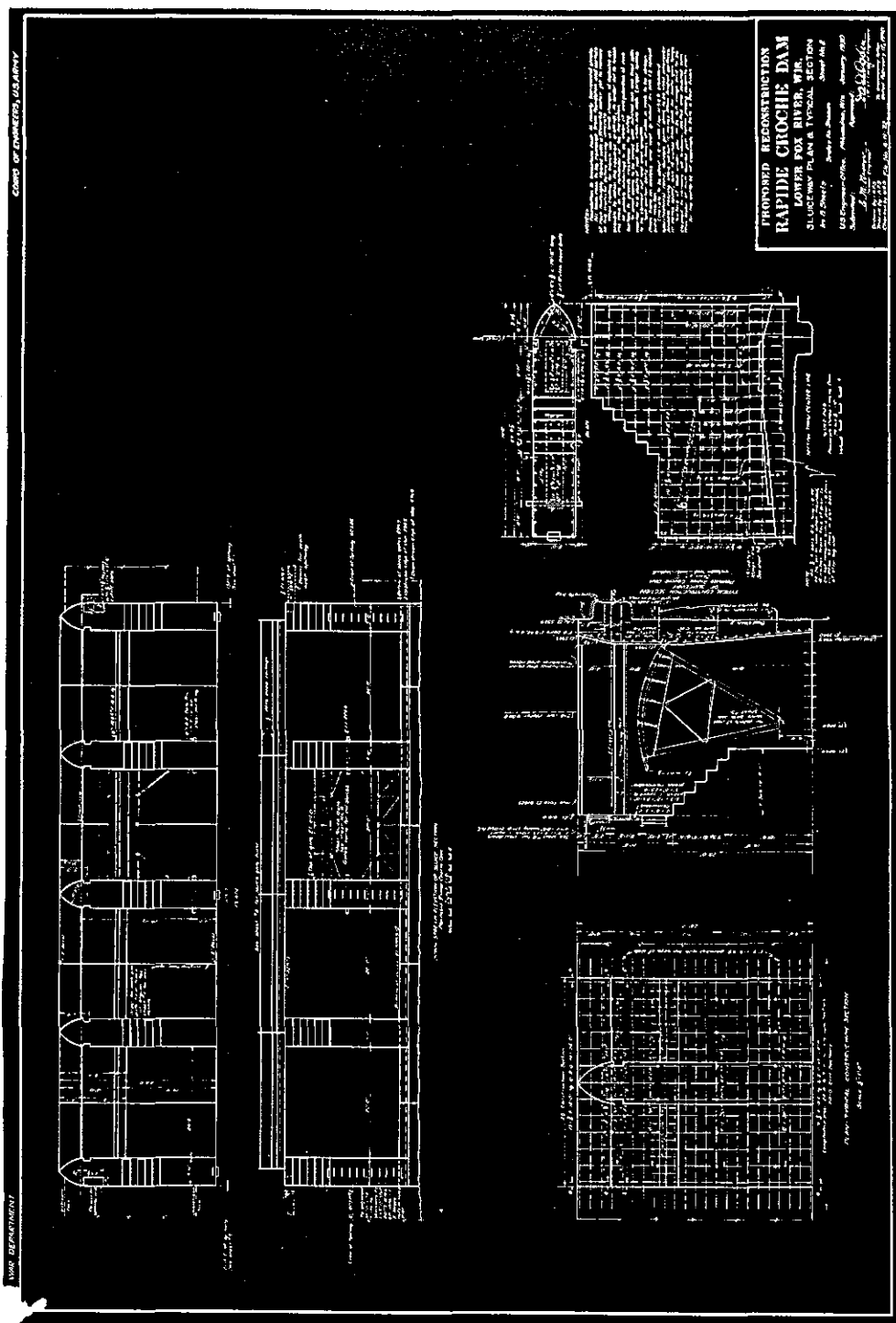
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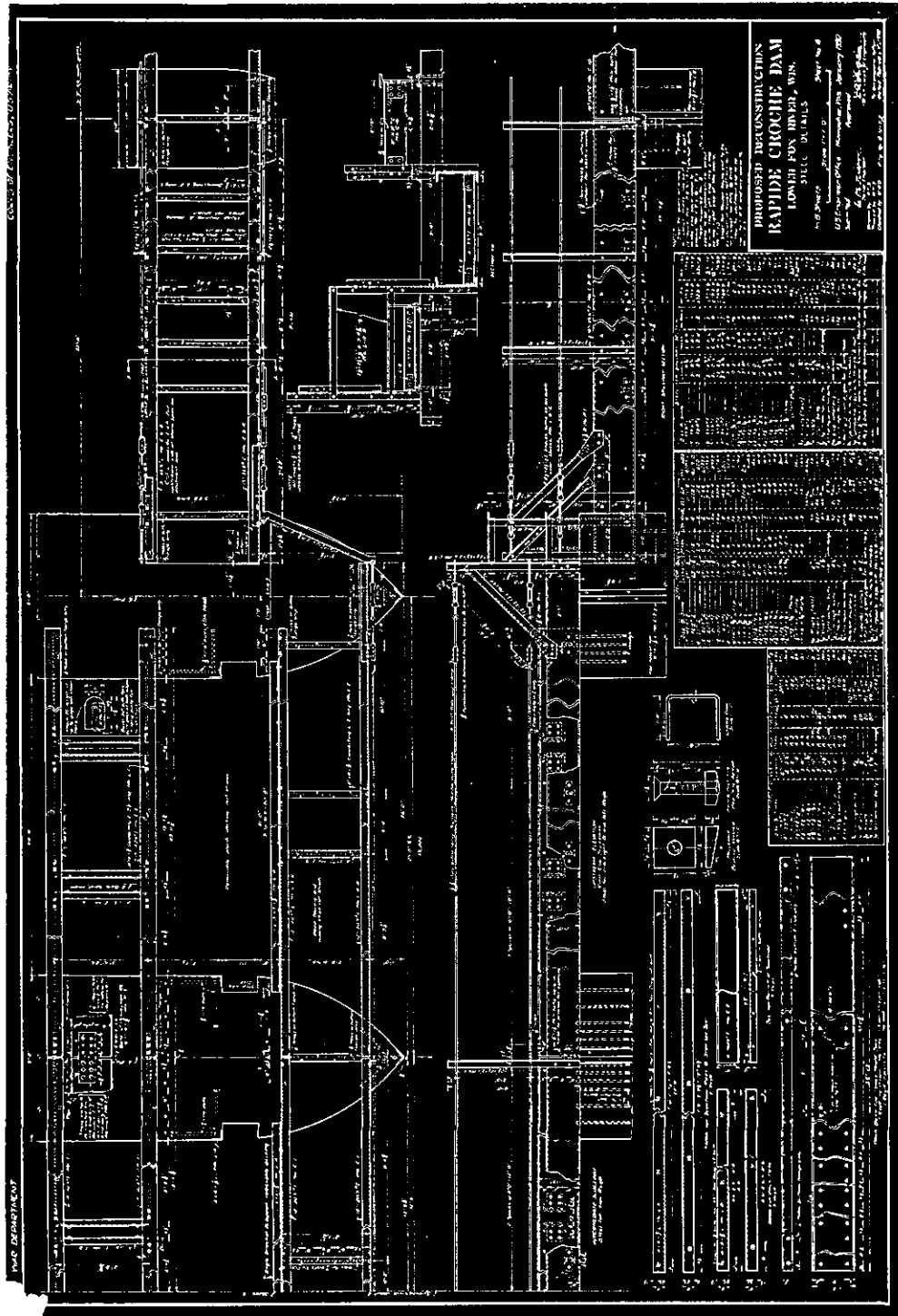
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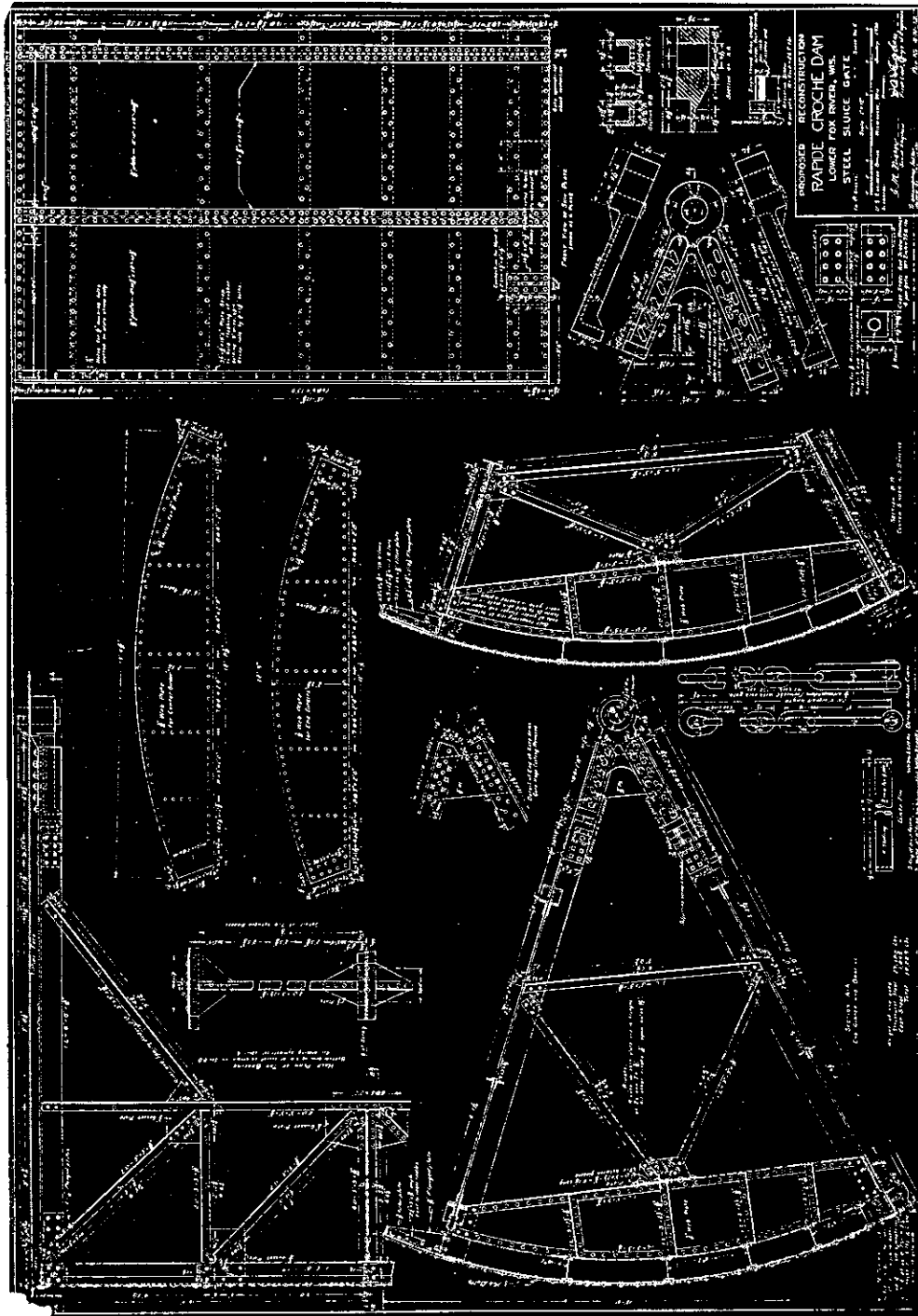
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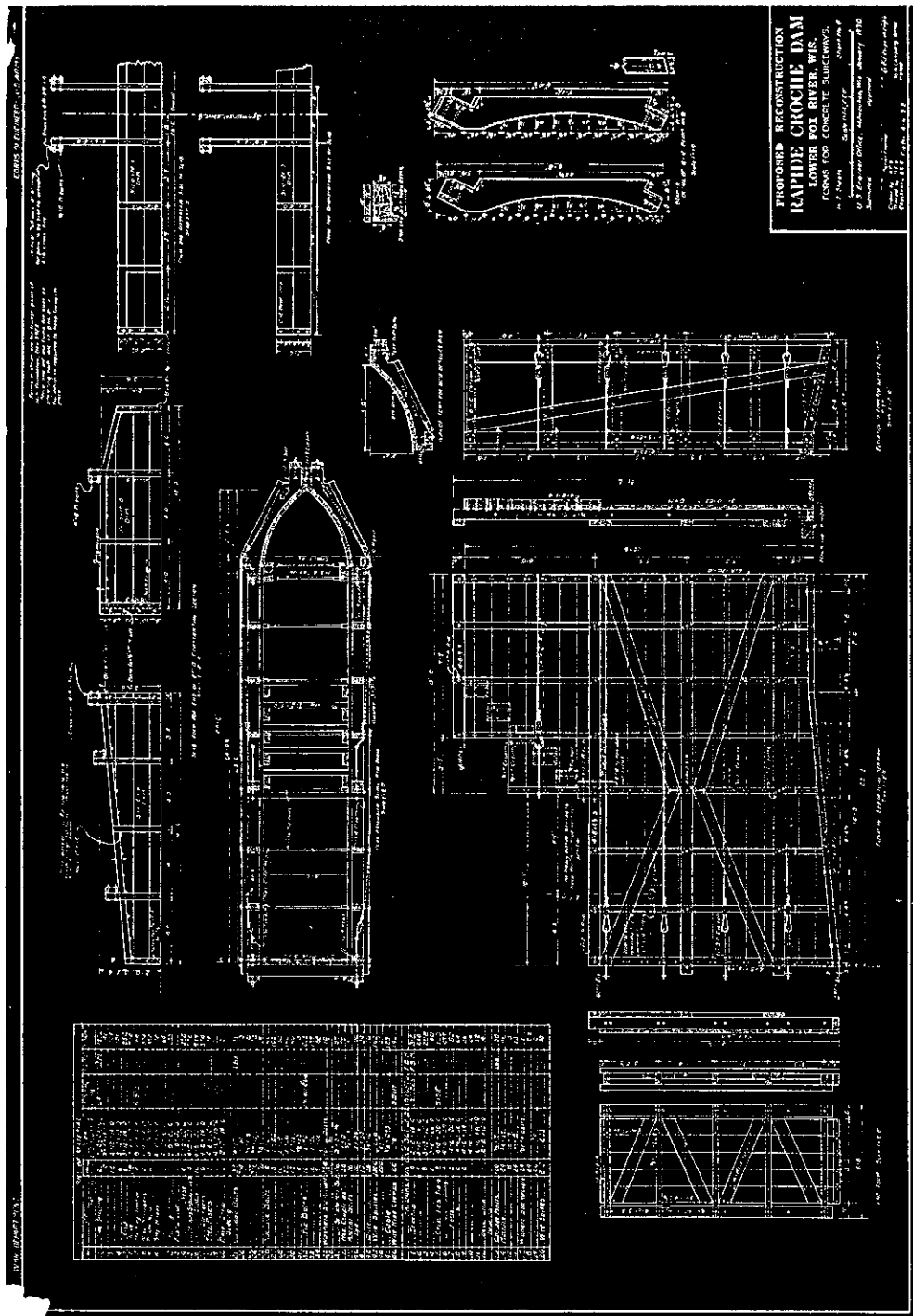
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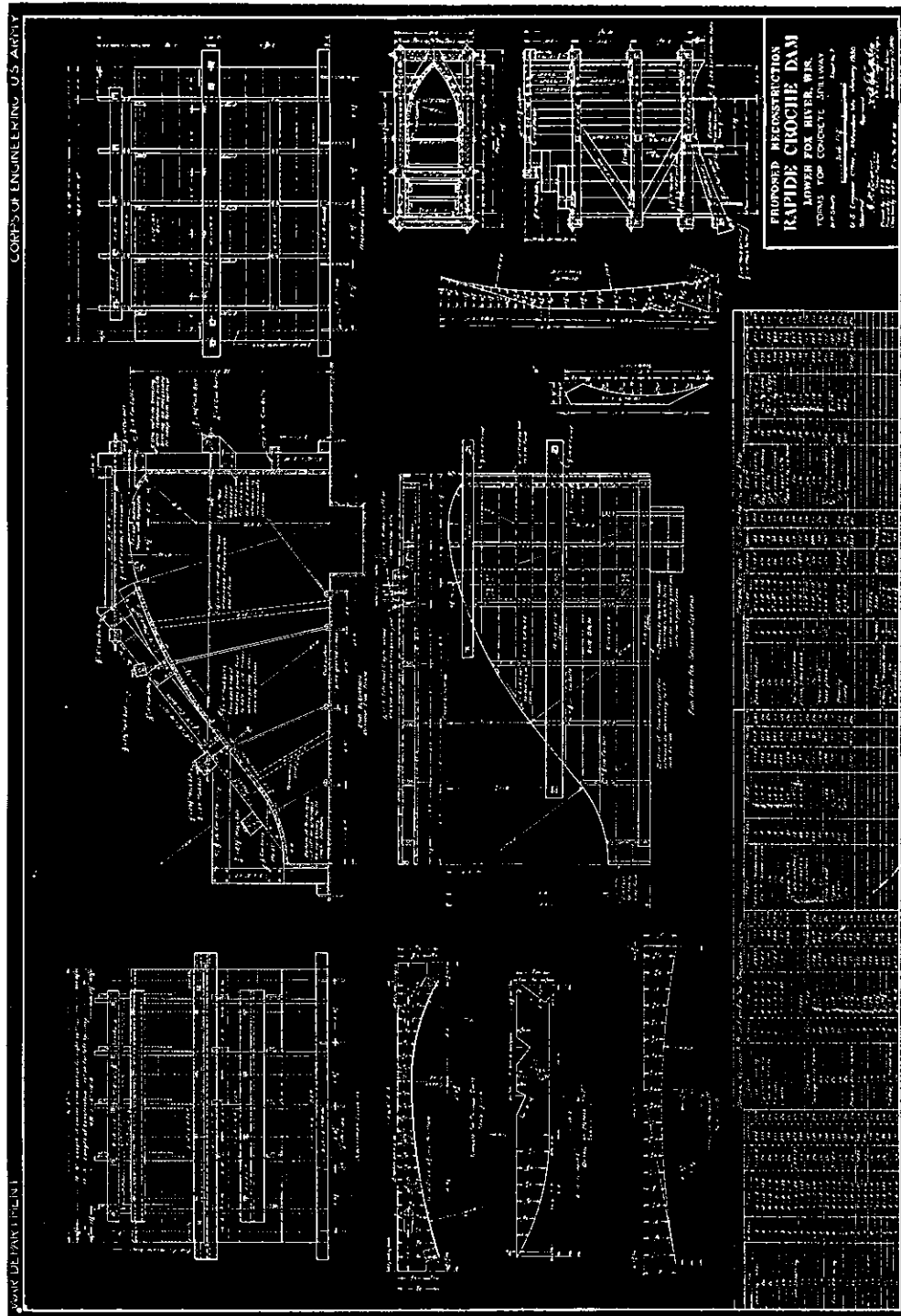
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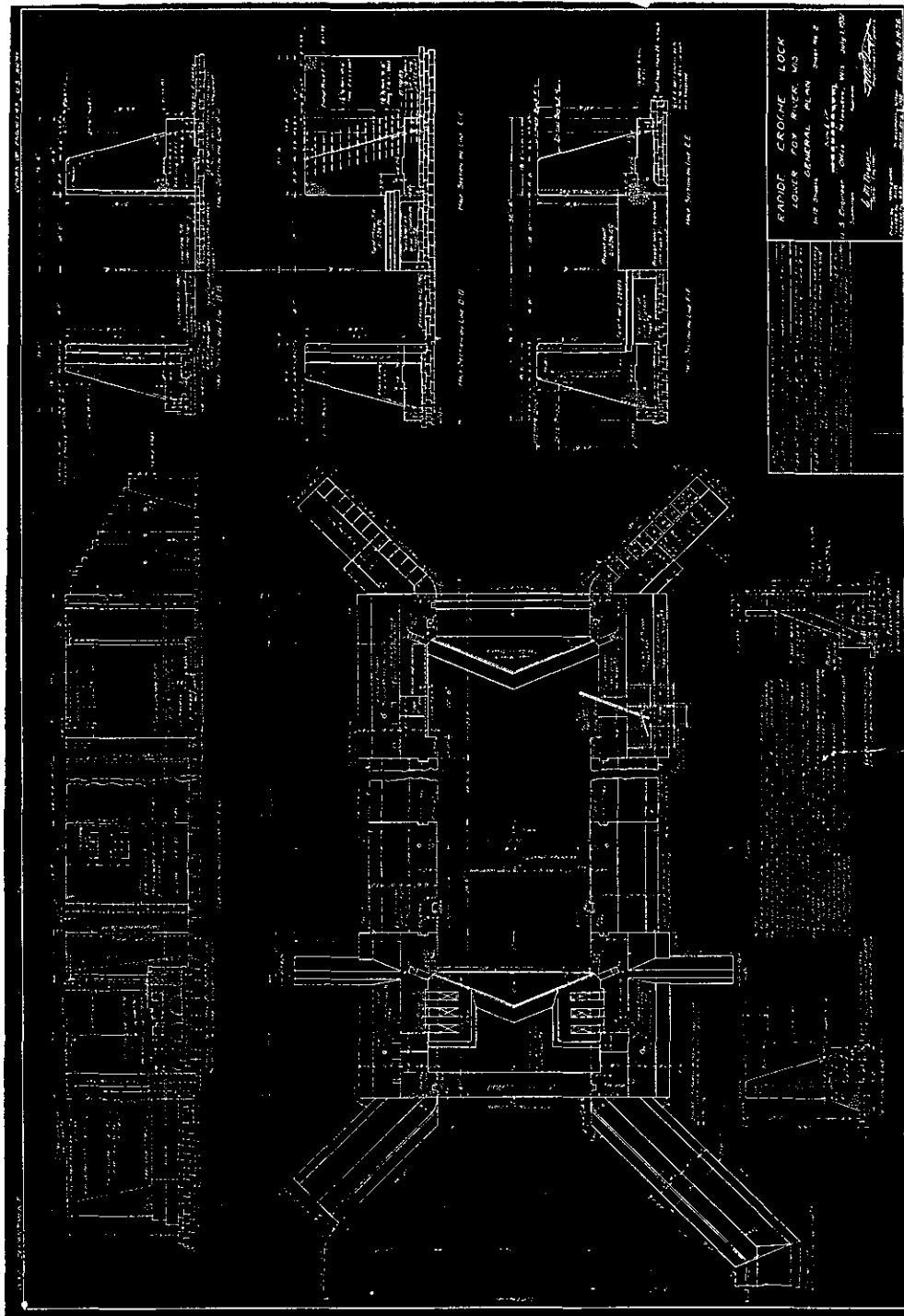
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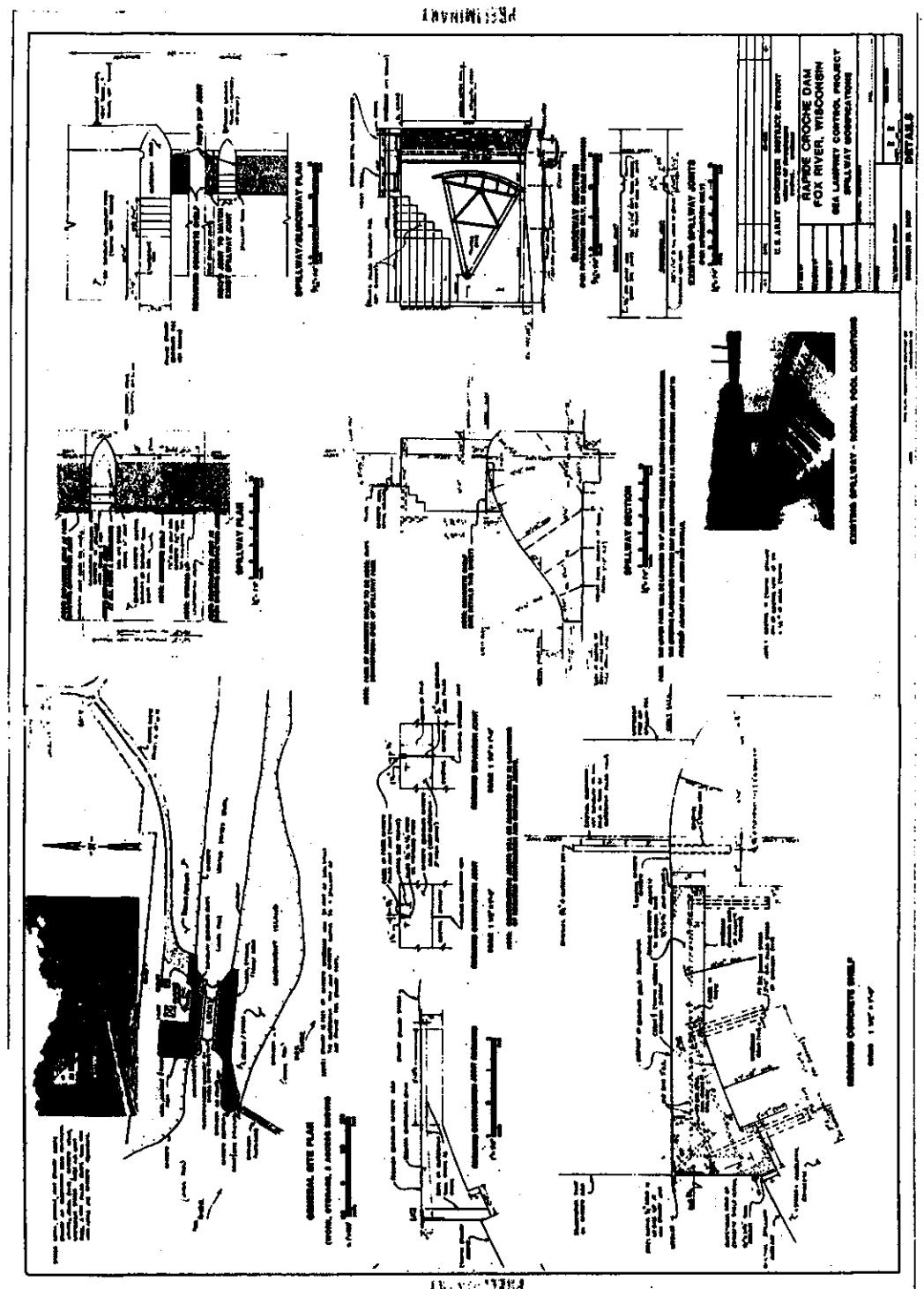


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